DOCUMENT RESUME

ED 363 688 CE 062 722

AUTHOR	Scribner, Sylvia; Sachs, Patricia
TITLE	Knowledge Acquisition at Work. IEE Brief Number 2.
INSTITUTION	Columbia Univ., New York, NY. Inst. on Education and the Economy.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.; Spencer Foundation, Chicago, Ill.; William T. Grant Foundation, Washington, DC. Commission on Work, Family, and Citizenship.
REPORT NO	ISSN-1059-2776
PUB DATE	Dec 91
NOTE	5p.
AVAILABLE FROM	Institute on Education and the Economy, Teachers College, Box 174, Columbia University, New York, NY 10027 (free).
PUB TYPE	Information Analyses (070)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Cognitive Style; *Intentional Learning; Learning Motivation; Learning Processes; Learning Strategies; *Management Information Systems; *Manufacturing; *Observational Learning; *On the Job Training; Postsecondary Education; *Technical Education; Work Environment

ABSTRACT

An exploratory investigation attempted to determine how learning at work actually takes place and in what ways learning on the job differs from classroom learning. The study was based on extensive observations and interviews over a 5-year period at two manufacturing plants that implemented a computer-based system known as Manufacturing Resource Planning (MRP). (MRP is both a computer system and a theory of manufacturing, designed to integrate information from all aspects of a company's operations to guide employees making production and inventory decisions.) The occupation of planner was selected for the core study since a planner within an MRP environment uses the system in relation to everyday production knowledge. Three knowledge domains were identified: MRP as a theoretical system, practical production knowledge, and functional production knowledge. The study found the following: (1) daily, everyday work activities are settings for learning; (2) without extensive academic, professional, or even on-the-job training, people can achieve conceptual understanding on the job; (3) how the workplace is set up, not the presence of technology, enhances or inhibits learning; and (4) because people come to their jobs from a large variety of routes, educational planners need to consider providing multiple and alternative educational forms as being as important as trying to design the one best training program. The study concluded that the workplace clearly is a learning environment and that people can learn formal concepts through work, not only in the classroom. (KC)

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

M Cannon

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

INSTITUTE ON EDUCATION AND THE ECONOMY

IEE BRIEF

ISSN 1069 2776

Number 2 / December, 1991

ED 363 688

KNOWLEDGE ACQUISITION AT WORK

Sylvia Scribner and Patricia Sachs

This Brief is dedicated to Sylvia Scribner, a pioneer in studies of workplace learning, who died on July 20, 1991.

The emergence of new information technologies in the workplace requires workers— novices as well as experts—to use computer-based systems on a daily basis. The rapid transformation of the modern workplace has created a situation in which workers must learn new systems of knowledge while at work. This Brief summarizes a research study designed to explore the nature of learning at work.

To test the long-held assumption that schooling is necessary for effective job performance, we investigated the impact of a computer-based technology on everyday jobs and on learning at work. Since most studies of knowledge acquisition are based on learning in the classroom, we wanted to determine how learning at work actually takes place and in what ways learning on the job differs from classroom learning.

The study summarized in this Brief is based on extensive observations and interviews over a five-year period at two manufacturing plants ("Kemps" and "Intek") that had implemented a computer-based system known as Manufacturing Resource Planning (MRP). The study was designed as an exploratory investigation and the first in a series of studies to compare the specific contributions of classroom learning and workplace learning to mastery of the same knowledge domain.

MRP is both a computer system and a theory of manufacturing, designed to integrate information from all aspects of a company's operations to guide employees making production and inventory decisions. The changes brought about by MRP exemplify the kinds of changes in job skills that new computer-based technologies are introducing into the workplace.

For the most part, MRP has not created new functions or jobs so much as it has modified work activities and transformed the conditions under which existing functions are carried out. MRP has affected jobs at all skill levels and markedly increased the intellectual demands of what was once considered unskilled labor. There is a formal curriculum for teaching the central principles of MRP, but the introduction of MRP into *existing* occupations means that much of the mastery of MRP's logic and theoretical concepts occurs on the job. This technology therefore provided us with an instance of a knowledge domain that is learned both in the classroom and on the job, giving us the opportunity to compare the effects of different routes to mastery—schooling and work-based learning.

Until now, studies of workplace learning have concentrated on activities employers have explicitly organized for the purpose of training, such as apprenticeships or on-the-job training programs. Our study focused instead on how workers use computers and achieve an understanding of them in the course of routine work. The inclusion of "normal work" as a learning activity distinguishes our approach from that of other researchers. We are comparing the educational implications of two activities, *working at planning* and *studying planning*, only one of which (classes) is institutionally designed to promote learning. One of our prime objectives was to develop methods for studying work from a learning perspective.

Publication and dissemination of this Brief is supported, in part, by funding from the William T. Grant Foundation Commission on Work, Family and Citizenship.

Our approach to studying how workers achieved an understanding of computer-based technology on the job was to learn, ourselves, how the technology fit into the factory environment. We knew that the plants did not function by MRP alone, and that workers had to have some grasp of the actual products being made as well as the processes involved in manufacturing and production. The questions were: Who knew how much about what? Do MRP workers understand production practices? Do shop floor workers understand MRP? We attacked these questions by thinking about the plant in terms of knowledge domains.

At the outset of the study, we saw two critical knowledge realms (and we know that others exist): MRP formal knowledge and everyday production practices. After preliminary observations and interviews, we added a third area—knowledge of how to use MRP functionally for work requirements. We knew that some workers would be expert in their knowledge of the production system while others would be expert in their knowledge of MRP. How did these two culturally defined systems of knowledge become integrated for workers in various occupations? We selected the occupation of Planner for our core study since the key function of a planner within an MRP environment is to use the MRP system in relation to everyday production knowledge.

Three Knowledge Domains

1. *MRP as a theoretical system.* MRP has been characterized as a theory of manufacturing. It exists as a formal system of knowledge, governed by central concepts. Its objects and procedures are generically defined, and the system is content-free until implemented in a particular plant. This is the knowledge taught in MRP instructional programs in community

CE 062 722

colleges and classes sponsored by professional groups. To some degree, workers need to understand the formal nature of MRP.

2. *Practical production knowledge.* The production system includes a wide variety of objects that are in continual transformation. The production world is content-rich, and there are multiple relations among objects. Unlike MRP, production knowledge is not formal, and can be extensively detailed in terms such as lead times, routing sequences, weights, sizes, and kinds of parts.

3. *Functional MRP knowledge.* Designed as a generic system that can be used for any kind of product, the classes and concepts of MRP are by necessity empty of content. When it is installed in a plant, concepts and classes in MRP need to be "filled" with actual instances; abstract concepts must become concrete within a particular setting. Knowledge of MRP as a theoretical system is thus inadequate, in and of itself, for effective performance on the job. Workers who use MRP to schedule production and control inventory must become acquainted with the actual material processes of production in a given plant in order to exercise judgment and handle non-routine events that arise in the course of work. Thus, expertise in the use of MRP on the job *requires* functional MRP knowledge—an integrated understanding of theoretical MRP knowledge and practical production knowledge.

The Effect of Work Organization on Learning

Since MRP is a relatively new technology, workers have learned MRP from the ground up—from already acquired experience on the job—rather than through vocational tracks in schools. People have been recruited to these jobs from the world of work rather than from the world of school. Even those workers who have upgraded their knowledge and skills through some form of schooling have done so *because* they were working in MRP-related jobs, acquiring *en route* training in MRP in community colleges, vendor-provided workshops, and through self-study as they moved from job to job and responsibility to responsibility. In most cases, this additional training was undertaken on the workers' own time and paid for by the workers themselves.

To understand how people learned MRP and production knowledge at work, we presented a set of quasi-experimental questions, based on observations of workers on the job as well as extensive study of MRP, to a selection of employees whose work focused on MRP (material control workers) or production (production and assembly workers), as well as workers whose jobs demanded contact with both these domains (planners). We included managers and union workers in our sample.

We found that differing employer implementations of MRP created work environments that offered different learning potentials for workers. In these two plants, there were substantial differences in the responsibilities of planners and the content of their work, depending on how each company had incorporated MRP into its business and designed the division of labor in its production and material control departments.

Kemps is an electronics manufacturing plant with a significant inventory to manage, producing 7,000 finished goods requiring 20,000 component parts. At the time of our study, Kemps had not fully implemented the production control and costing model of MRP; as a result, planners at Kemps did not have access to updated information about the status of manufacturing and production.

In sharp contrast, Intek had a fully functioning MRP system that the company used to achieve efficient production. All of Intek's planning for purchases and production takes place within a framework that functions as a budget of the plant's capacity. An MRP team drawn from many departments regularly evaluates the plant's performance and the work of individual planners.

At Intek, a planner's central function is to schedule manufacturing orders—reviewing orders against capacity, assigning them to particular machines, and scheduling them according to priority considerations. Intek's planners schedule orders eight weeks in advance, but each week they review all orders in light of changing conditions. In this process, they tell MRP which orders can and which ones cannot be changed by the computer system itself. One week before orders go into production, planners' recommendations are reviewed by others in the group. Research, judgment, and decision-making with regard to orders are thus completed through individual and collaborative work over a number of weeks.

In contrast, Kemps planners are not involved in scheduling. Their central function is reviewing and releasing orders for items in their product lines when the MRP system recommends them for release. Planners can countermand these recommendations, but they do not take control of the scheduling as the Intek planners do. Further, although individual planners cooperate with one another to exchange information, no collective activity is involved in their normal work.

In short, planning at Intek is a more responsible, broader-range job than at Kemps, and this results from the difference in the way work is organized at the two companies, not from the presence of MRP. The different implementations of MRP affect planners' responsibilities and, in turn, the intellectual content of their jobs. If normal work activities are settings for learning, planning at Intek and planning at Kemps have different learning potentials.

Indeed, different implementations of MRP affect the intellectual content and learning potentials of all related jobs. Given appropriate job

responsibilities, it appears that workers acquire conceptual understanding through work activities without any classroom-based instruction. Some work activities, in and of themselves, are educationally rich. They enable workers to approach problems on the job in an experimental way: specifying problems, developing hypotheses for their solution, testing solutions, and discussing these issues with co-workers. We do not know whether educationally-rich work activities are substitutable for school, but the evidence in this study suggests that they might be. It is a hypothesis worth pursuing.

Formal Knowledge. We found that material control workers achieved some mastery of MRP concepts, whether or not they had any formal training in MRP. The supervisor of the material control department demonstrated conceptual understanding of formal MRP although he had attended only one weekend MRP training seminar. We can only conclude that he mastered these concepts in the course of his work. The people who performed poorly on questions about formal MRP knowledge had little exposure to MRP on the job and had no formal MRP training. However, even those who worked with MRP intermittently were able to achieve at least a medium score on formal knowledge.

Analysis of the performance of both Kemps and Intek employees strongly suggests that while formal knowledge of MRP can be learned in school-like activities (courses or self-study), it can also be learned through actual job activities, especially when some features of conceptual knowledge (quantity relationships, for example) take on particular salience in those activities.

Production knowledge. Production knowledge requires both an understanding of the production system as a whole and a knowledge of the concrete things that exist in the production world. We found that production supervisors possessed the greatest depth, extent, and richness of knowledge along these two dimensions, but supervisors and managers in material control also possessed deep and extensive knowledge of these domains.

Although planners had the least production knowledge, they had a command of the basics. And it was clear that planners' understanding was not confined to the MRP system or its model of production, but also embraced the flow of the business enterprise as a whole; for example, how an order for a product comes into the house, or what kinds of manufacturing and assembly operations are required to complete the order.

Functional MRP knowledge. Although people who use the system regularly at Kemps initially learned fixed formulas for solving routine problems, most—including planners—failed to recognize when these were not relevant and did not use their knowledge to formulate a procedure to fit novel situations. Production workers were wholly unable to perform the particular tasks we created, but material control supervisors and managers performed them competently.

With limited training and—compared to Intek's planners—restricted work responsibilities, Kemps' planners have achieved some mastery of MRP concepts and logic, but do not display a deep grasp of its basic principles. In fact, Kemps planners exhibit the same profile across the three knowledge domains. In each—formal MRP knowledge, functional MRP knowledge, and production knowledge—they have a grasp of essential concepts and contents, but in each their knowledge appears limited compared to another occupational group within their company. Since all planners included in this study are considered competent in their job performance, we conclude that they can address the requirements of their jobs at Kemps without achieving deep mastery of any of the three knowledge domains.

Summary and Implications

Analyzing knowledge systems in the context of work practices is an enormously complex undertaking. Because of the exploratory nature of our investigation, this pioneering effort has produced suggestive rather than definitive findings.

1. Daily, everyday work activities are settings for learning. When workers participate in the performance of work tasks along with others, knowledge acquisition is an institutional by-product. The production of connectors also produces people who know about connectors and how to make them. The knowledge individuals acquire of a domain—their understanding of concepts and facts—is closely linked to the specific nature of their work activities and the design and social organization of the workplace itself. How we interact with people, objects, and concepts shapes what we learn and understand about them.

2. Without extensive academic, professional, or even on-the-job training, people can achieve conceptual understanding on the job. We have various strands of evidence: Several individuals without any formal study of MRP approached formal tasks the same way as workers who had had some study. Intek planners with only some study performed as well as the Kemps planner who had been trained and certified by the American Production and Inventory Control Society (APICS).

We found that some workers in these two companies are able to integrate MRP concepts with concepts of usage, trend, forecast, and production knowledge. Some understand items not only as objects to be ordered, but as parts that can be constructed in a variety of ways. They also understand that policy considerations affect choices, for example, whether to purchase or manufacture a part. In other words,

Institute on Education and the Economy
Box 174, Teachers College, Columbia University
New York, New York 10027
212-678-3091
Director: Thomas R. Bailey

some of the workers understand that determining how many parts to order is not simply a math problem; it involves an understanding of timing, production costs, lead times, and part types.

How the workplace is set up—not the presence of technology—is what enhances or inhibits learning. A company that organizes planning simply as a set of segmented tasks will limit what its workers learn. Whether in the workplace or the schoolroom, what is emphasized and encouraged in the setting helps people develop either a conceptual understanding or a highly routinized, inflexible set of responses. The question for both educators and employers is: What kinds of skills do they want workers or students to acquire?

3. Since people come to their jobs from a large variety of routes, educational planners need to consider providing multiple and alternative educational forms as being as important as trying to design the "one best" training program. The learning of theoretical concepts cannot be approached by policymakers as an "either school/or on the job" question. Many kinds of skills that educators have assumed could only be learned in school or school-like settings are learned on the job by people who possess no formal education or training beyond high school. That does not mean that the workplace is the best place to learn, or that learning on the job is the best way to learn. But if people can develop conceptual understanding on the job without school-based training, the workplace is clearly a *potential* learning environment. What educators, employers, and policymakers need to understand is how to tap that potential.

To address the question, "Is learning in the context of practice more effective than classroom learning?", one needs to specify "for what?" Formal schooling and nonformal, everyday, practical activities may be substitutable for each other with respect to mastery of some aspects of a formal domain. Policymakers who want to test this hypothesis can develop demonstration work-based learning programs that provide the same conceptual tools as APICS classes. A further requirement would be work activities that promote the use of these conceptual tools. In their long-range planning for the development of work-related knowledge and skills, educators and policymakers should not limit themselves to programs with explicit educational objectives.

In conclusion, this study leaves us with some unanswered questions. While it is well-known that workers acquire production knowledge through work experience, we know little about how workers integrate abstract concepts with concrete content. It is clear that, in the modern factory, people operate in parallel worlds: one is MRP; the other is production. Some people relate to objects through the computer system; they know *representations* of objects (e.g., #K-22-91). Others relate to objects as things (with weight, size, cost, difficulty of storage, etc.). A planner cannot be good unless she or he can bridge these two worlds. How do they learn to do this? What knowledge realms do they access? How do individuals construct their understandings of these systems? These are important questions for further research.

Further Reading

Sachs, P. (1989). *Thinking through technology*. Paper presented at the conference on New Information Technologies, Swedish Information Services.

Sachs, P. (1990). *Work practices, knowledge, and culture: Organizational confusion*. Paper presented at the Society for Applied Anthropology Meetings, York, England.

Scribner, S. (1984). Studying work intelligence. In Lave, J. & Rogoff, B. (Eds.), *Everyday cognition: Its development in social context* (pp. 9-40). Cambridge, MA: Harvard University Press.

Scribner, S. (1989, August). Learning and working in an activity theory perspective. In R.D. Pea (Chair), *Learning at work: An interdisciplinary perspective*. Symposium conducted at the American Educational Researcher's Association 1989 Annual Meeting, San Francisco, CA.

Scribner, S. & Sachs, P. (1990). *A study of on-the-job training*. Technical Paper No. 13. New York: Institute on Education and the Economy, Teachers College, Columbia University.

This Brief is a distillation of a paper by Sylvia Scribner and Patricia Sachs, with Lia Di Bello and Jessica Kindred, entitled *Knowledge Acquisition at Work*. The study was sponsored by the Office of Educational Research and Improvement, U.S. Department of Education, and the Spencer Foundation. The paper is available from the Institute on Education and the Economy for $7.50. Please prepay orders with checks payable to IEE Publications.